Building Performance Simulation (BPS) Software for Planning of Energy Efficiency Retrofits

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Building Performance Simulation (BPS) Software for Planning of Energy Efficiency Retrofits

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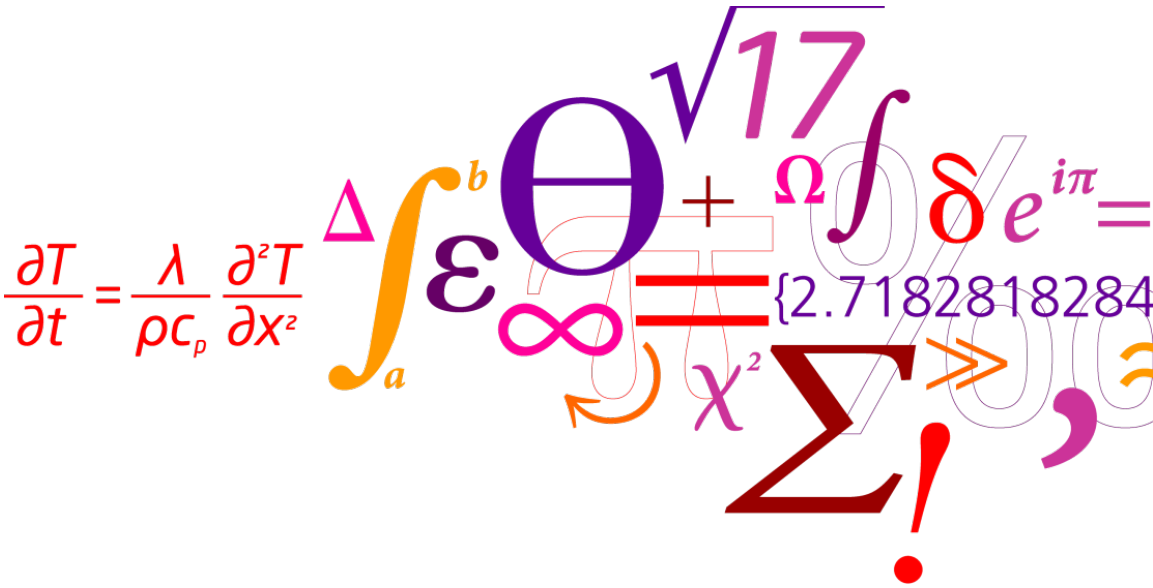

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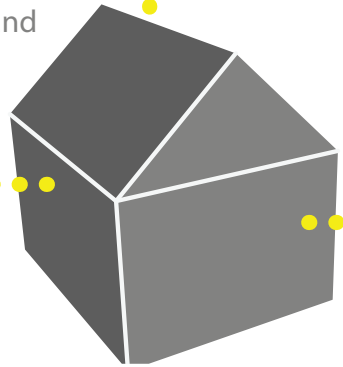
Study Background

- **Selecting Retrofit Strategies**
  - When planning a retrofit, multiple performance strategies and actions has to be considered.
  - How to select the most appropriate retrofit strategy/actions?
  - A decision support methodology is needed.
  - Possible solution: Implementing Building Performance Simulation (BPS) software as a performance-based decision-making tool.

Strategy 1: Building envelope and design aspects
Actions: Insulation upgrades, air leakage reduction, improvement of doors and windows, control and exploitation of solar gain and daylight, etc.



Strategy 2: Building systems and installations
Actions: Installation of high-efficiency HVAC systems, improvement of electrical lighting systems, improvement of domestic appliances, installation of renewable energy, etc.

Strategy 3: Building services and management tools
Actions: Monitor and control of the building during operation, utilization of metering services, clock controls, sensors, etc.

Study Goals

- **Multifaceted Study**
  - The main purpose is to describe a methodology to facilitate BPS software as a performance-based decision-making tool.
  - The methodology is implemented and tested in a retrofit case study.

Case Study Framework

- **Gate 21 Pilot Project**
  - The case study is directed towards the Gate 21 pilot project ”Building Envelope Retrofits: Retrofitting of Danish Social Housing”.
  - The case study aims to develop multiple exemplar building envelope retrofit actions, which can be adopted into future projects.
  - The case study focuses on integrating BPSs as a performance-based decision-support tool.
- **Clients Requirements**
  - The client (Gate 21) wishes to develop building envelope retrofit actions optimized for solar radiation and daylight exploitation.
  - Retrofitting focus: Investigating different building envelope design variables, particularly, different window positions, sizes, and shapes.

GATE 21 SUSTAINABLE FUTURE FORUM

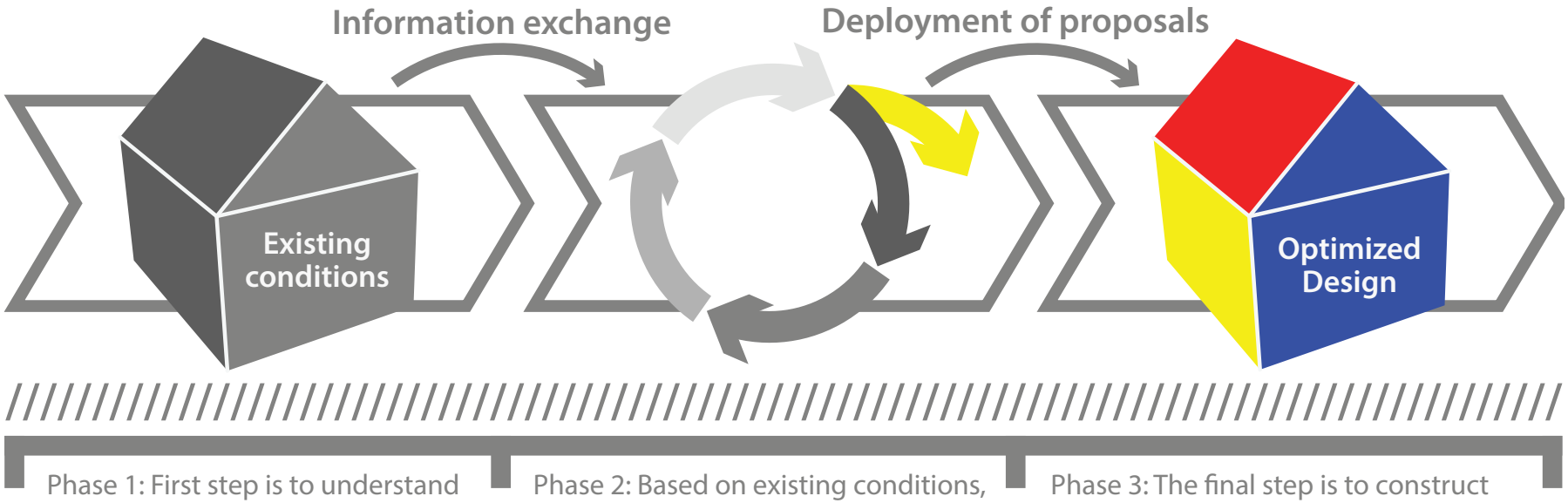
DEN EUROPÆISKE UNION
Den Europæiske Fond for Regionaludvikling

DTU Technical University of Denmark

Case Study Methodology

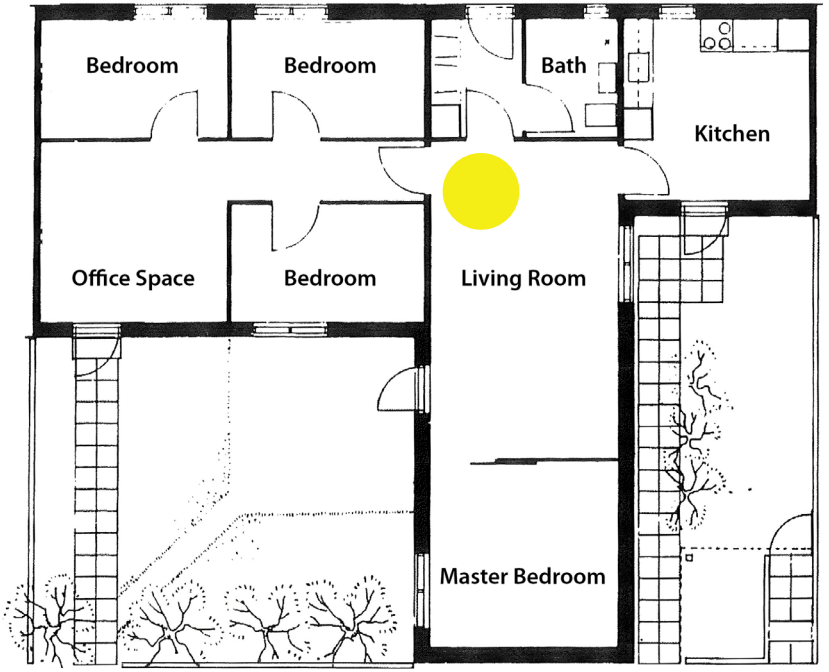
- **Simulation-based process**
  - The simulation-based retrofit design process consists of three phases:

    (1) Analysis of existing conditions
    (2) Development of retrofit strategies/actions (+ evaluation)
    (3) Implementation of retrofit strategies/actions



Case Study Investigations [1/4]

- **Analysis of Existing Conditions**
  - The dwelling used for the retrofit case study is a precast concrete construction, 1970s single storey house in Albertslund, Denmark.
  - Pre-retrofit buildings conditions: Aging window units, poor insulation, air leakage, and mould growth due to surface condensation.



Case Study Investigations [2/4]

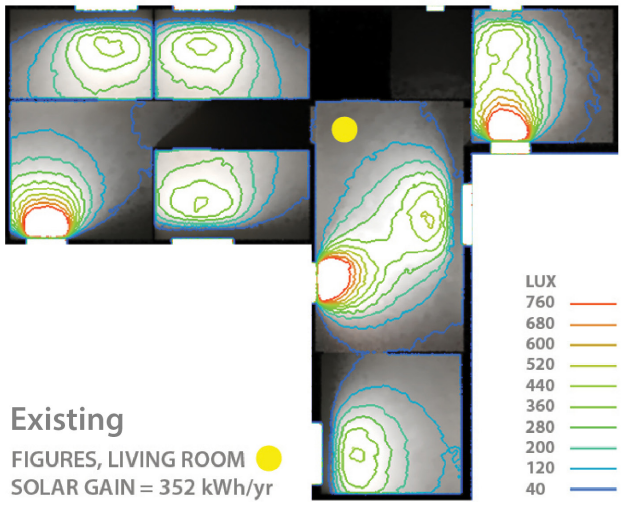
- **Development of Retrofit Strategies/Actions**
  - Retrofit actions focus on investigating selected building envelope design variables: Alternative window positions, sizes, and shapes.
  - List of retrofit actions:

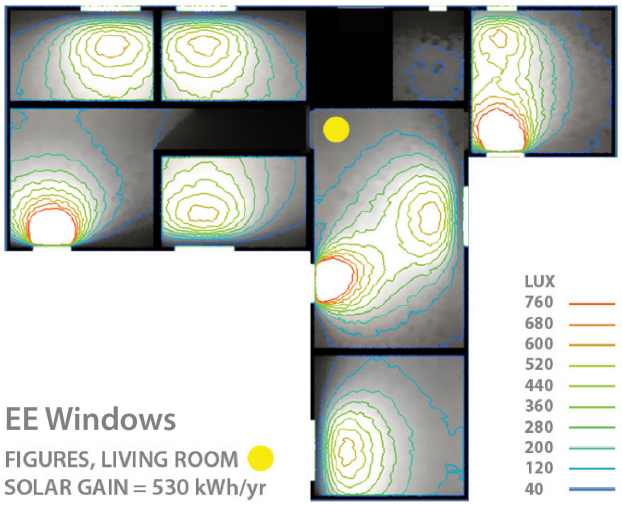
Action (0): Existing conditions
Action (1): Energy efficient windows
Action (2): Energy efficient windows + increased window width
Action (3): Energy efficient windows + increased window height
Action (4): Energy efficient windows + extra window section at patio doors
Action (5): Energy efficient windows + double patio doors
Action (6): Energy efficient windows + small skylight in living room
Action (7): Energy efficient windows + large skylight in living room
Action (8): Energy efficient windows + extra window section in living room
Action (9): Energy efficient windows + extra window section in master bedroom

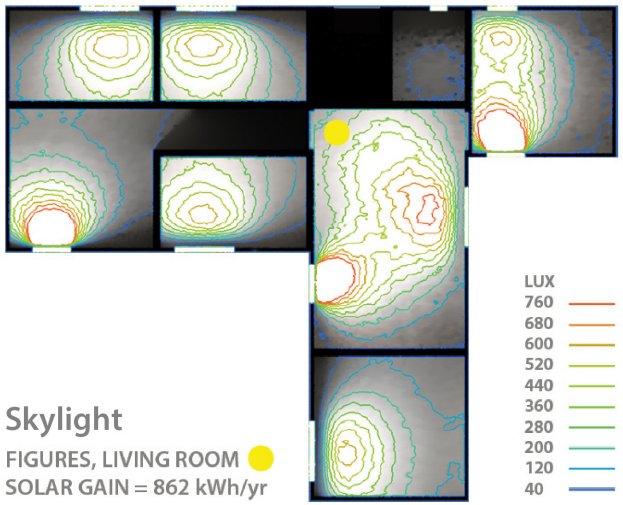
Case Study Investigations [3/4]

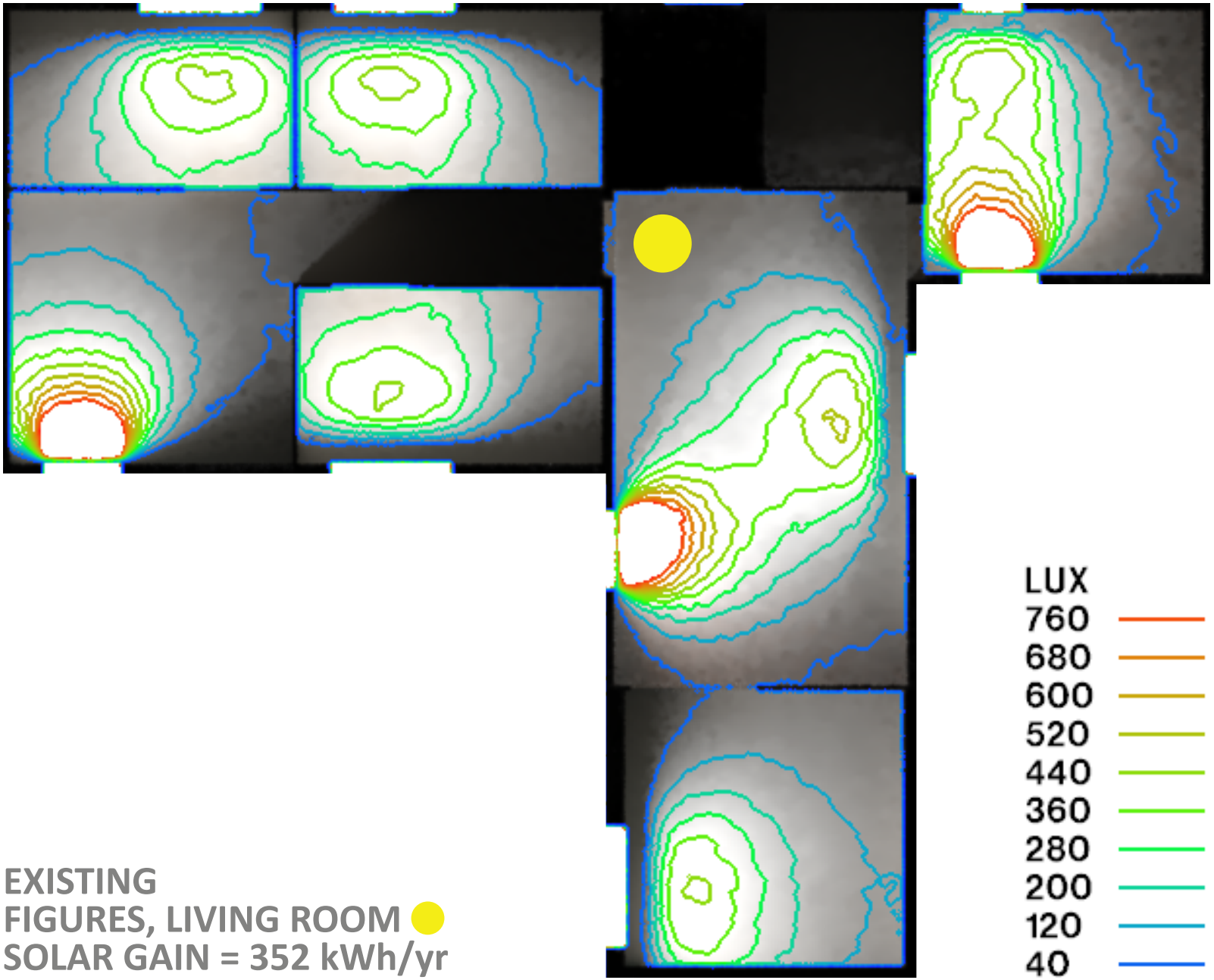
- **Development of Retrofit Strategies/Actions**
  - BPS software is used to investigate the retrofit actions; simulation of interior solar gains and daylight distribution [performed in IESVE].

    HERE: Average annual solar gains and daylight distribution, mapped over existing conditions, Action 1, and Action 7, contour range 40-760 LUX.

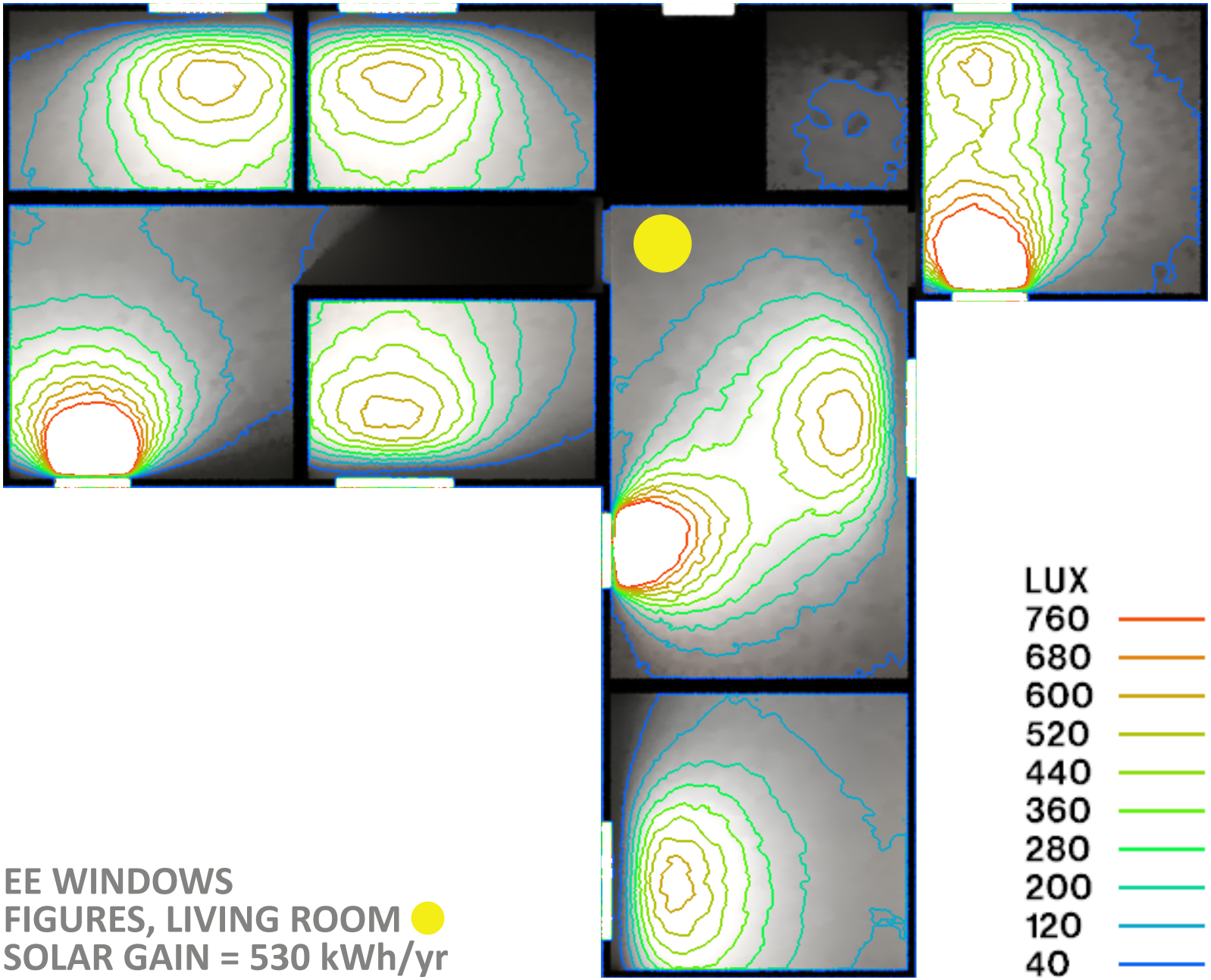




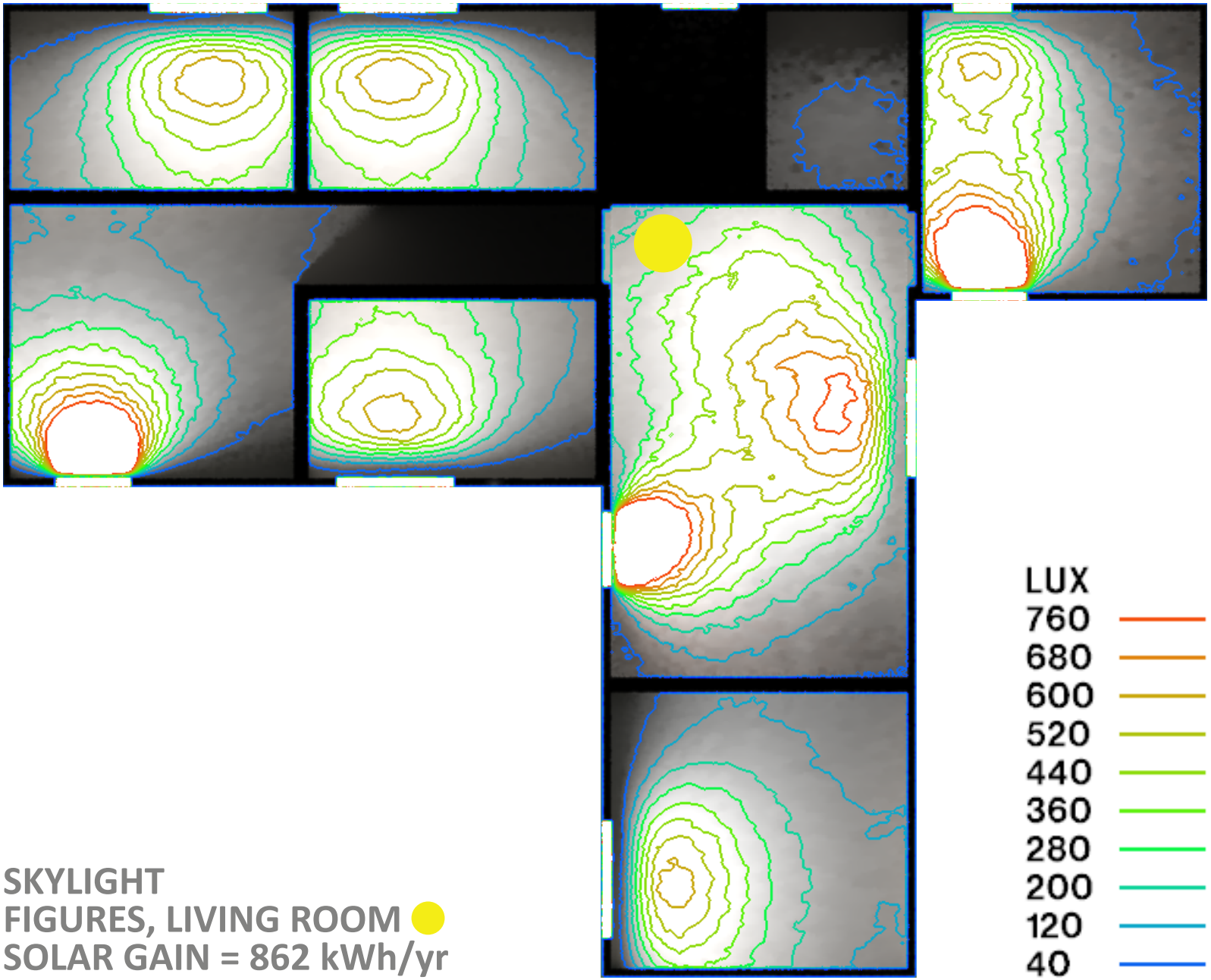




EXISTING
FIGURES, LIVING ROOM
SOLAR GAIN = 352 kWh/yr



EE WINDOWS
FIGURES, LIVING ROOM
SOLAR GAIN = 530 kWh/yr



SKYLIGHT
FIGURES, LIVING ROOM
SOLAR GAIN = 862 kWh/yr

Case Study Investigations [4/4]

- **Implementation of Retrofit Strategies/Actions**
  - The client should select specific retrofit actions within the developed solution space.

Conclusions

- **Implementation of Retrofit Strategies/Actions**
  - In the decision-making process of selecting specific retrofit strategies, multiple actions are available.
  - Therefore, a decision support is needed.
  - BPS can be implemented as a performance-based decision-making methodology.

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